ELEVATED CITY HELIPADS: SAFETY AND DESIGN

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Abstract. In 1995, the International Civil Aviation Organization (ICAO) published Annex 14 to the Convention on International Civil Aviation. In volume II, it established a standard code for international heliport design in the interest of safe helicopter operations. Since this publication, the number of helipads has increased dramatically in urban areas of the world, notably in Brazil, the United States, Japan and urban parts of South East Asia but also at sea and near hospitals in most parts of the Western world. While the specifics of the manual determine the size and markings of the upper surface, the problems of helipad construction on rooftops have changed from an engineering to an architectural concern for which the guidelines of ICAO are not always sufficient or relevant. Helicopter navigation, noise abatement, passenger access and rooftop congestion for elevated city helipads benefit from an optimal design that requires elements not (yet) specified by ICAO regulations.

1. INTRODUCTION TO HELICOPTER PLATFORMS

Helipads are placed on roofs for the purpose of safety. Helipads in congested areas, such as cities, have difficulty providing an approach route free of obstacles and repeatedly confront a pilot with confined areas that require attention.
With the increase of rooftop helipads in Brazil, as a result of flexible regulations and fashion, and with the increase of helicopters assisting hospital emergency services, the number of helipads in city areas has increased significantly in the last twenty years. In addition, skyscrapers in the Middle East, South East and East Asia have received helipads and rescue paths as part of their safety features even though few if any helicopters make regular landings on these platforms. They mimic the mandatory helicopter platforms on high-rise buildings in California of which the use is also restricted to emergency operations. [1]
The Brazilian and to a lesser extent the Asian helipads have received increasing attention from architects that integrated the designs into the building as a whole. Hospitals were confronted with a separate problem. They needed elevator constructions to move stretchers with patients to the helipad or into the hospital building.
The increase of rooftop helipads has amplified the need for solutions to their specific problems either from ICAO regulations [2] or from advisors in the industry [3]. Some of the solutions are already found in the outer corners of the world but are not well publicized. Others are part of recent research. The insights summarized in this study provide a start for optimizing future helipad design.

2. NAVIGATION

São Paulo in Brazil has such a high number of helipads per square kilometer that navigation to any one of them has become increasingly complicated. The Brazilian solution to this problem consists of code markings and a booklet 'Pilot's Help' that

lists the helipads, provides their coordinates and often adds an aerial photograph [4]. A similar online guide is found for a set of European helipads on www.helipad.org.
The city of São Paulo in Brazil has the highest density of active helipads in the world of which the majority is found on rooftops. They distinguish private, hospital and military helipads that are marked with the letters P, H and M, respectively. Hospital helipads are marked with a cross in which a letter H is visible in a different color. Most helipads show a triangle to indicate the landing direction in addition to a letter and a call sign. In most cases, the maximum tonnage allowed on the helipad is indicated with numbers, usually in the same color as the other markings.
The Brazilian practice differs only mildly from the ones found in the United States, Japan and parts of Western Europe. The minimum size of the platform in Brazil is larger and the one-letter codes are different apart from the letter H. Both in Brazil and elsewhere there is, however, much variation in color schemes.
The vast majority of helipads in Brazil is colored blue with yellow or white markings. Lines and letters are commonly the same color. Variations exist for hospitals where there is often a red or white cross with a yellow H inside. Green and few red helipad surfaces are also found with either yellow or white markings. A common practice for ground-based and older rooftop helipads is a concrete grey surface with white or yellow lines, obviously a less expensive variation.

Photo 1. Tinelli Building by Carlos Bratke, São Paulo, Brazil, with typical color scheme and markings.

Hospital helipads often include three colors: the surface area, the cross and the markings. The cross is invariably red or white with either a grey, green or blue background color. The markings and the H is usually the same color of which yellow is the most common.
Although the colors are diverse, there is a search for contrasts. Also the upper surface has an extra layer to provide the helicopter with the necessary grip and this additional layer simply comes in different colors. There is clearly no standardization or knowledge about the optimal color scheme for safety purposes. A general survey of helipads elsewhere in the world did not hint at a standardized color scheme for other countries either. More importantly, heliport manuals and ICAO's guide for heliport design does not mention the ideal color scheme. [2,3]

Optimal visibility from the air and thereby readability of the lettering from altitude are much enhanced with appropriate color schemes. On the basis of literature in psychology, the best results are found with blue lettering and a yellow background, the worst with a blue background and a white lettering. [6] Even if it does not become part of official regulations, this color scheme is a simple improvement of helipad design practice.

3. NOISE ABATEMENT

The reduction of noise in city areas is on the one hand assisted by specified approach paths through less sensitive areas and on the other hindered by such approaches since they increase the number of flight movements for a specific area. Historically, city airports and heliports were located near rivers to minimize noise complaints. [1,7] Unfortunately, even the heliport designed by Sir Norman Foster on the banks of the London Thames was thwarted by concerns of people living on the scenic river banks.
In the absence of ideal locations and next to the introduction of more quiet helicopters, adding rather than limiting the number of helipads may reduce noise levels.
Regulations advise to standardize the approach routes for safety reasons, intensifying noise levels above one specific area only. A choice of helipads on buildings allows helicopters to use different approaches and limit the noise generated for a specific area, particularly if the number of flights movements for multiple helipads is equal to that of a single helipad. Although this recommendation in helipad design may sound counterintuitive, a high number of helipads near each other is unproblematic if only a one of them is in use at any one time. The practice of multiple helipads on one roof is currently used for hospitals to allow more than one emergency helicopter to land or to facilitate the parking of one helicopter without obstructing the access to the hospital. Research on the benefits of noise reduction for dual helipad designs is still wanting.

Photo 2. Hospital of the University of Pennsylvania double helipad surrounded by rooftop amenities.

4. PASSENGER ACCESS

Hospital and lighthouse helipads are complicated by patient and passenger access facilities. Recent elevator engineering solves this issue for hospitals. The specific case of British lighthouses with their trap-door through the landing area has to remain an exception in European regulations. [1,3]
In a newly built hospital it is possible to install an elevator that reaches through the roof. It then opens its door for stretchers and when it goes down it also closes the surface of the helipad. This way the helipad remains free of obstacles. Although an ideal solution for limiting the obstructive elevator facilities on hospital rooftops, it is both expensive and exclusive to new buildings.
The necessity of elevators for bringing patients from the helipad to the inner building has created an obstacle for which few architects have found a solution. The Mater Dei hospital in Belo Horizonte is one of few helipads that is free of obstacles by installing a wide ramp that brings stretchers to a lower floor that features the necessary elevator. Depending on the size of the roof, this is one of few solutions to the hospital access problem. [4,5]
The solutions to elevator obstructions on helipads require that engineers and architects cooperate. In many cases the engineers are specialized in helipad construction but then the construction of ramps and elevators may already have been completed. In fact, the design of a building rather than the design of the landing surface itself determines if safe and optimal helicopter operations can take place.

Photo 3. Mater Dei Hospital, Belo Horizonte, Brazil, ramp construction that leads to elevators on a lower floor.

5. ROOFTOP CONGESTION

The few architects who wish to integrate helipads in the overall building design are particularly concerned with the free approach and maneuvering that a helicopter requires. The various architectural solutions to this problem have been explored in a recent study and are revisited here for their implications on present regulations [1,7].
A few architectural designs can be distinguished that aim to move the helicopter away from obstacles on the building. Next to elevator constructions these obstructions include

but are not limited to air conditioning units and air vents, antennas and satellite dishes, railings for stairwells and the presence of other buildings in the vicinity.
On oilrigs the helipad is often moved on an arm away from the rig. This construction is also used for some recent skyscrapers, particularly if the helipad is not placed on the top of the building. It is similar to the overhanging helipad that is placed out of center and partly overhangs the roof so that it is away from and leaves space for other rooftop constructions.
Another design puts helipads on a pedestal that towers above the other rooftop amenities. Although this makes the use of elevators near impossible, it solves most problems. In this case the passengers climb a steep set of stairs to a free view of the surrounding area.
In some congested areas it is possible to place the helipad between the roofs of two buildings. This construction allows for an optimal distance away from other and perhaps taller buildings in the vicinity.
The above choices for constructing safe helipads are known to most Brazilian architects but are rarely publicized outside Brazil. These architectural ideas assist in the development of safe helipads around the world and go beyond what is advised in ICAO's regulations.

Photo 4. Millenium Park by Botti Rubin Architects in São Paulo, Brazil. Helipad placed between two buildings.

6. CONCLUSION

ICAO regulations for the safe operations of heliports have not changed after 1995. Apart from the construction of the landing surface that includes elevators and color schemes, guidelines for safe helipad design should also address urban planning and architectural elements that include but are not limited to problems of noise abatement, passenger access and rooftop congestion. Although the role of ICAO is perhaps limited in these areas, it is clear that its manual does not suffice for an optimal helipad design. The engineering and architectural developments in helipad designs from around the world point towards safer constructions in the future as long as the ideas are noted and implemented.

7. REFERENCES

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